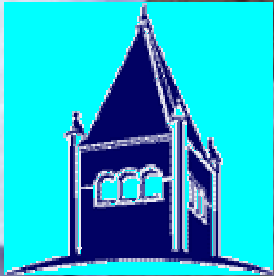


Responsible Enhancement of Estuarine Species: Opportunities, Constraints & Tackling Uncertainty

Science Consortium for Ocean Replenishment

Ken Leber
Mote Marine Laboratory
Sarasota, FL

Science Consortium for Ocean Replenishment (SCORE)



**University of
New Hampshire**



Hatchery Reform



**NMFS Manchester
Laboratory**



Science Consortium for Ocean Replenishment

Circa 1975, Scientists finally recognize the need for assessing the effects & effectiveness of stocking

- Little or no attention was given to evaluating hatchery impact during the 1st 90 years of stocking programs in the USA
- Only during the past decade-and-a-half has research (anywhere) focused on effectiveness of stocking marine fish and shellfish
- Research on marine stocking is 2 decades behind freshwater stocking



Science Consortium for Ocean Replenishment

Stock Enhancement is a New "Science"

Symptoms:

- Little Published on Effects Until 1989
- No Agreed Upon Terminology
- No Textbooks on Stock Enhancement
- No Accepted Synthesis of What the Key Issues Are
- Scientific Method is Underutilized

Leber, In: Stock Enhancement & Sea Ranching, Blackwell, Oxford, p 63-75, 1999

BULLETIN OF MARINE SCIENCE

vol. 62, no. 2, pp. 303-714 (1998).

**PROCEEDINGS OF THE SYMPOSIUM MARINE STOCK ENHANCEMENT:
A NEW PERSPECTIVE
THE 1996 WILLIAM R. AND LENORE MOTE INTERNATIONAL SYMPOSIUM
November 20-23, 1996, held in Sarasota, Florida, USA**

Critically Assessing Stock Enhancement: An Introduction to the Mote Symposium
JOSEPH TRAVIS, FELICIA COLEMAN, CHURCHILL GRIMES, DAVID CONOVER, THERESA BERT, AND MICHAEL TRINGALI

Cod Enhancement Studies in Norway---Background and Results with Emphasis on Releases in the Period 1983--1990
TERJE SVASAND

Assessment of Stock Enhancement of Barramundi, *Lates calcarifer* (Bloch), in a Coastal River System in Far Northern Queensland, Australia
M. A. RIMMER AND D. J. RUSSELL

Stock Enhancement in Japan: Review and Perspective
REIJI MASUDA AND KATSUMI TSUKAMOTO

Survival of Stocked Red Drum in Texas
LAWRENCE W. MCEACHRON, ROBERT L. COLURA, BRITT W. BUMGUARDNER, AND ROCKY WARD

Enhancing Lobster Stocks: A Review of Recent European Methods, Results, and Future Prospects
R. C. A. BANNISTER AND J. T. ADDISON

Recruitment Patterns of Cultured Juvenile Pacific Threadfin, *Polydactylus sexfilis* (Polynemidae), Released along Sandy Marine Shores in Hawaii
KENNETH M. LEBER, NATHAN P. BRENNAN AND STEVE M. ARCE



Stock Enhancement and Sea Ranching - Book Information - Mozilla

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Science Consortium for Ocean Replenishment

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Stock Enhancement and Sea Ranching

Edited By: BARI HOWELL, B R Howell, CEFAS, Conwy Laboratory, UK.
BARI HOWELL, CEFAS, Weymouth Laboratory, Dorset
Erlend Moksness, Flodevigen Marine Research Station, Institute of Marine Research, Norway
Terje Svasand,
Terje Svasand, Institute of Marine Research, Bergen, Norway

"Stock Enhancement and Sea Ranching is a very important text and should stand on the shelves of all those involved in stock enhancement in both the marine and freshwater environments" - L...

More Reviews

Stock enhancement and sea ranching has been practised for decades for a wide variety of marine fish and invertebrate species in Japan, and for salmonids. As a result, fisheries scientists and managers worldwide have been encouraged to use these techniques to increase the productivity of existing fisheries, to create new fisheries, and to restore those that are no longer viable. Projects are now under way not only in Japan, but on cod in Norway, striped mullet in Hawaii, red drum in Texas, white seabass in California, scallops in New Zealand, shrimp in China and sturgeons in the Caspian Sea, to name a few. This edited work, based on the first International Symposium on Stock Enhancement and Sea Ranching, presents and discusses advances in these techniques and their consequences and sets out to identify the most important priorities for future research.

Contents

Introduction: Can the conditions for a successful enhancement or sea ranching be defined?;
Section 1: Theoretical considerations: Recruitment limitation as the theoretical basis for stock enhancement;
Ecological framework for enhancement potentials;
Genetic considerations in enhancement and ranching of marine and anadromous species;
Genetic diversity and the Norwegian sea ranching programme: an evaluation

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Stock Enhanc...

10:14 PM



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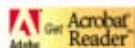
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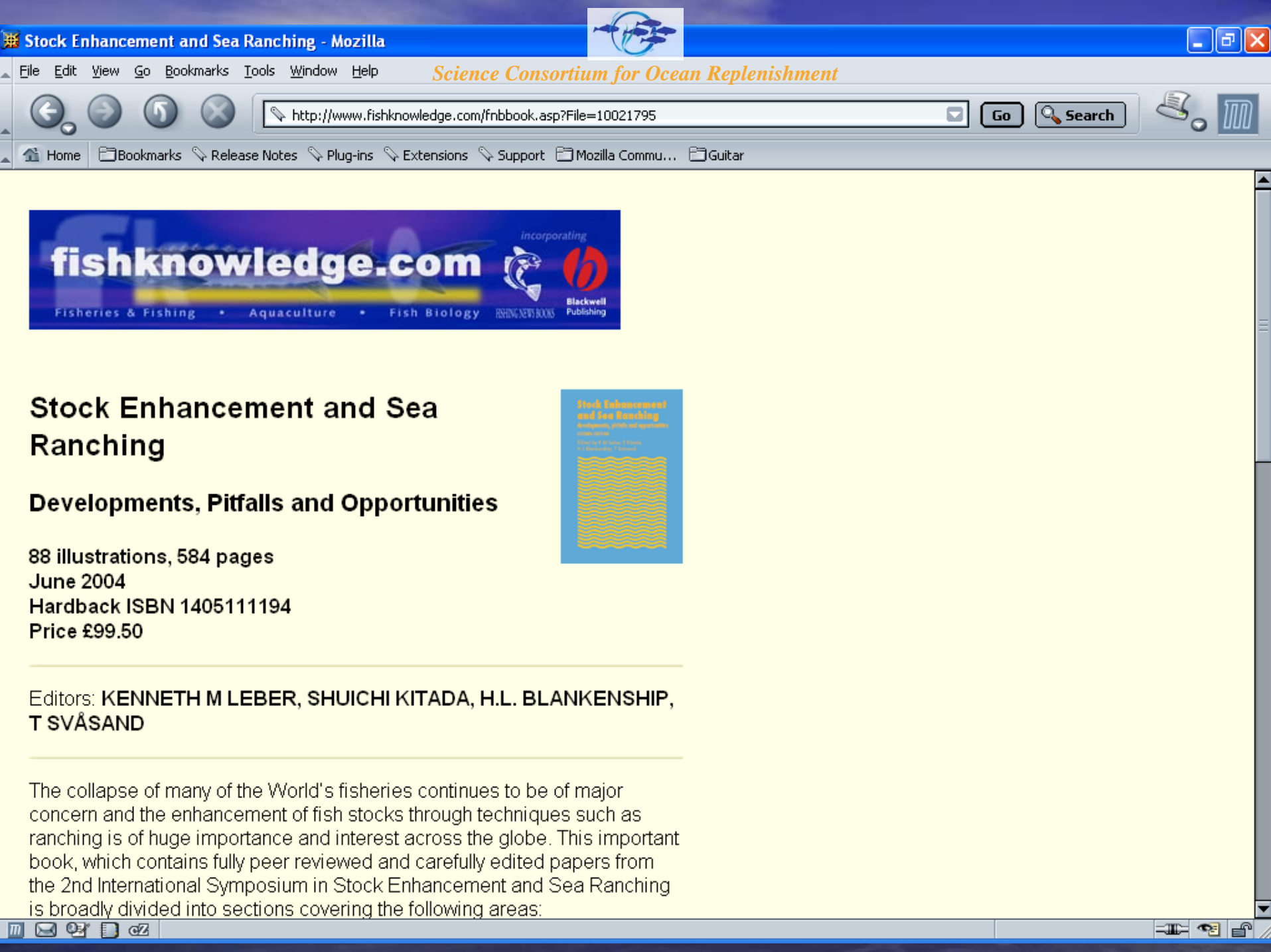
[Kobe Portopia Hotel](#)[Kobe City](#)[Hyogo Prefecture](#)

Second International Symposium on Stock Enhancement and Sea Ranching

**Date:**

January 28th - February 1st in 2002

Place:Kobe Portopia Hotel,
Kobe city, Hyogo Prefecture Japan**Host:**Fisheries Agency, Government of Japan
&
Japan Sea-Farming Association



http://www.fishknowledge.com/fnbbook.asp?File=10021795

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Stock Enhancement and Sea Ranching

Developments, Pitfalls and Opportunities

88 illustrations, 584 pages

June 2004

Hardback ISBN 1405111194

Price £99.50



Editors: **KENNETH M LEBER, SHUICHI KITADA, H.L. BLANKENSHIP, T SVÅSAND**

The collapse of many of the World's fisheries continues to be of major concern and the enhancement of fish stocks through techniques such as ranching is of huge importance and interest across the globe. This important book, which contains fully peer reviewed and carefully edited papers from the 2nd International Symposium in Stock Enhancement and Sea Ranching is broadly divided into sections covering the following areas:



Science Consortium for Ocean Replenishment

Can stocking be cost effective?
Finally, we're investigating optimal
release strategies to maximize cost
efficiency of stocking.





Science Consortium for Ocean Replenishment

A Responsible Approach to Marine Stock Enhancement *

- Develop Species Management Plan:
 - 1. Prioritize Species for Enhancement
 - 2. Identify Harvest & Genetic Objectives
- Develop Sound Enhancement Strategy:
 - 3. Define Quantitative Measures of Success
 - 4. Use Genetic Resource Management to Prevent Inbreeding
 - 5. Use Disease and Health Management
 - 6. Consider Ecological, Biological & Life-History Patterns
 - 7. Identify Hatchery Fish & Assess Stocking Impact
 - 8. Use Experiments to Identify Optimum Release Protocols
 - 9. Identify Economic & Policy Guidelines
 - 10 Use Adaptive Management

(* **Blankenship & Leber**, *American Fishery Soc Symp* **15:165-175, 1995**)

PDF is online at www.StockEnhancement.org/science/publications.html



Tag technology has made quantitative assessment a reality



Tag Selection



Science Consortium for Ocean Replenishment

Coded-wire Tag (CWT)

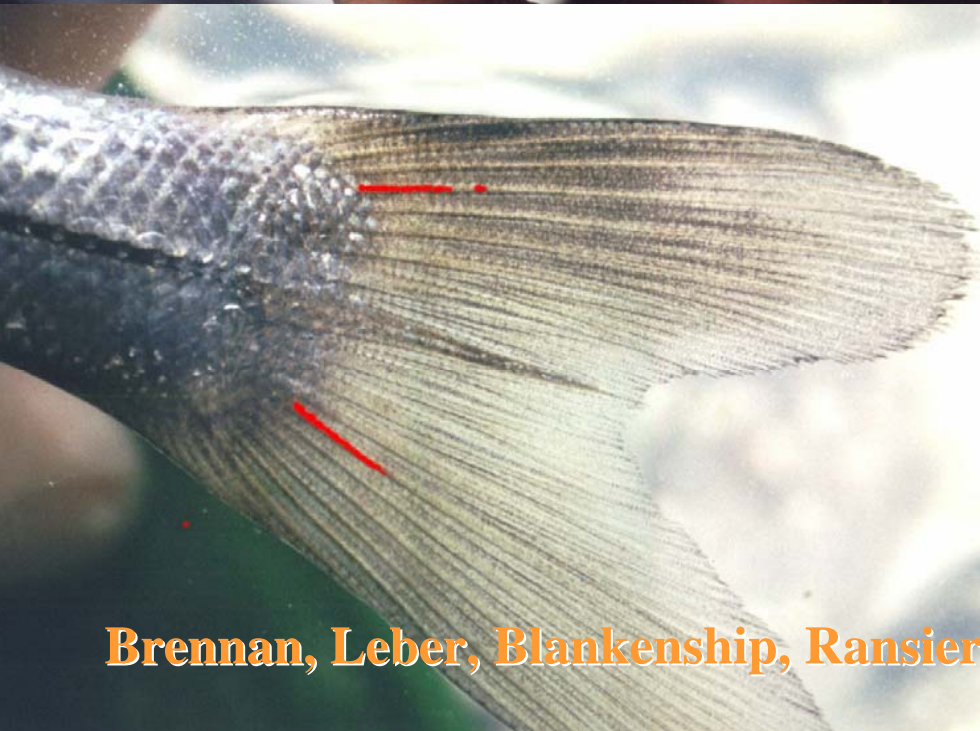
- Benign
- Easily and quickly applied
- Works well with small and large fish
- High retention, retained over lifetime of individual
- Cost effective, (~\$0.1/Tag)
- High information content
- Not externally visible in most cases, must use detector
- Must sacrifice individual to remove tag for decoding
- Useful for double tagging studies: external tag retention, survival, growth





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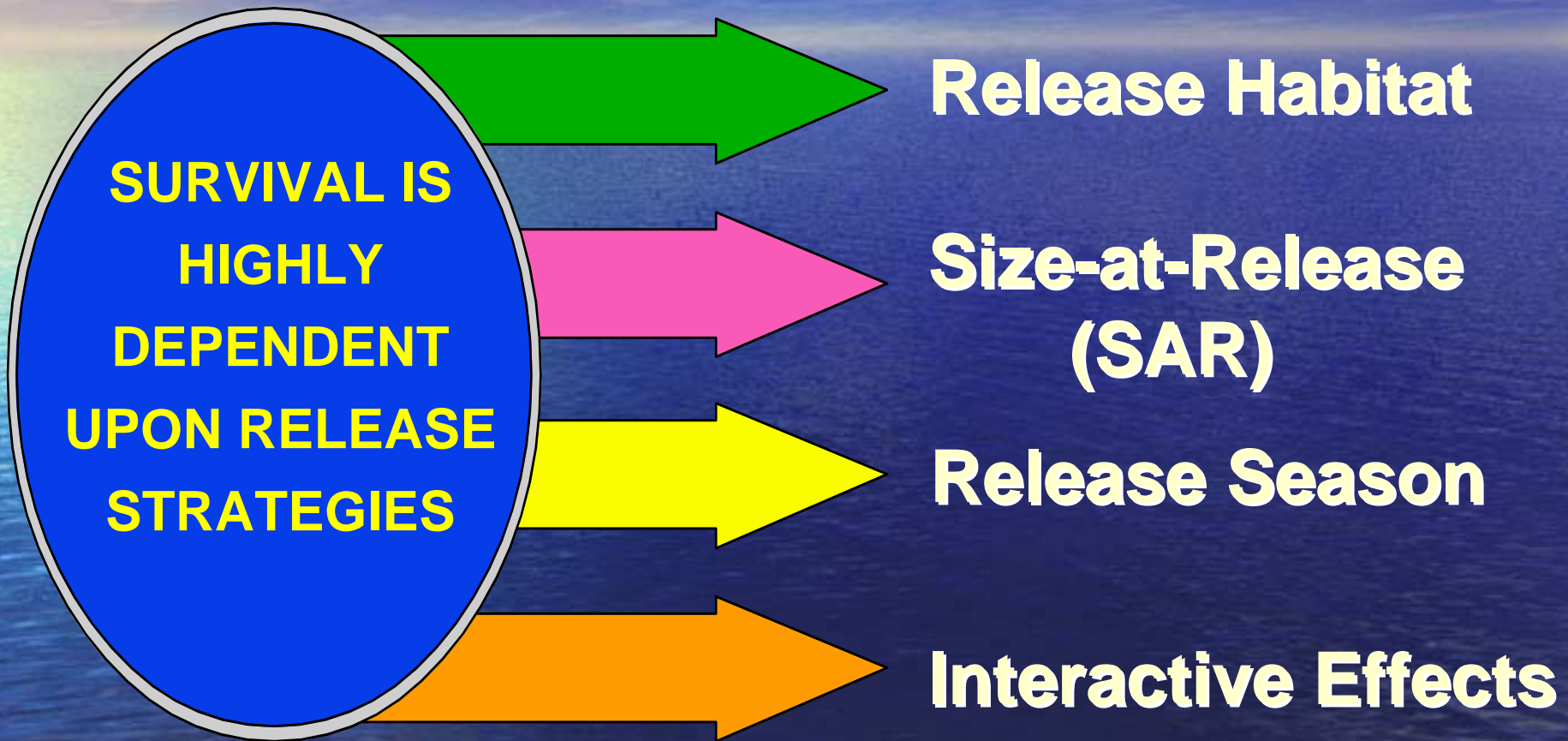
Visible Implant Elastomer Tag



Brennan, Leber, Blankenship, Ransier, DeBruler, *NAJFM* 23: 437-445, 2005



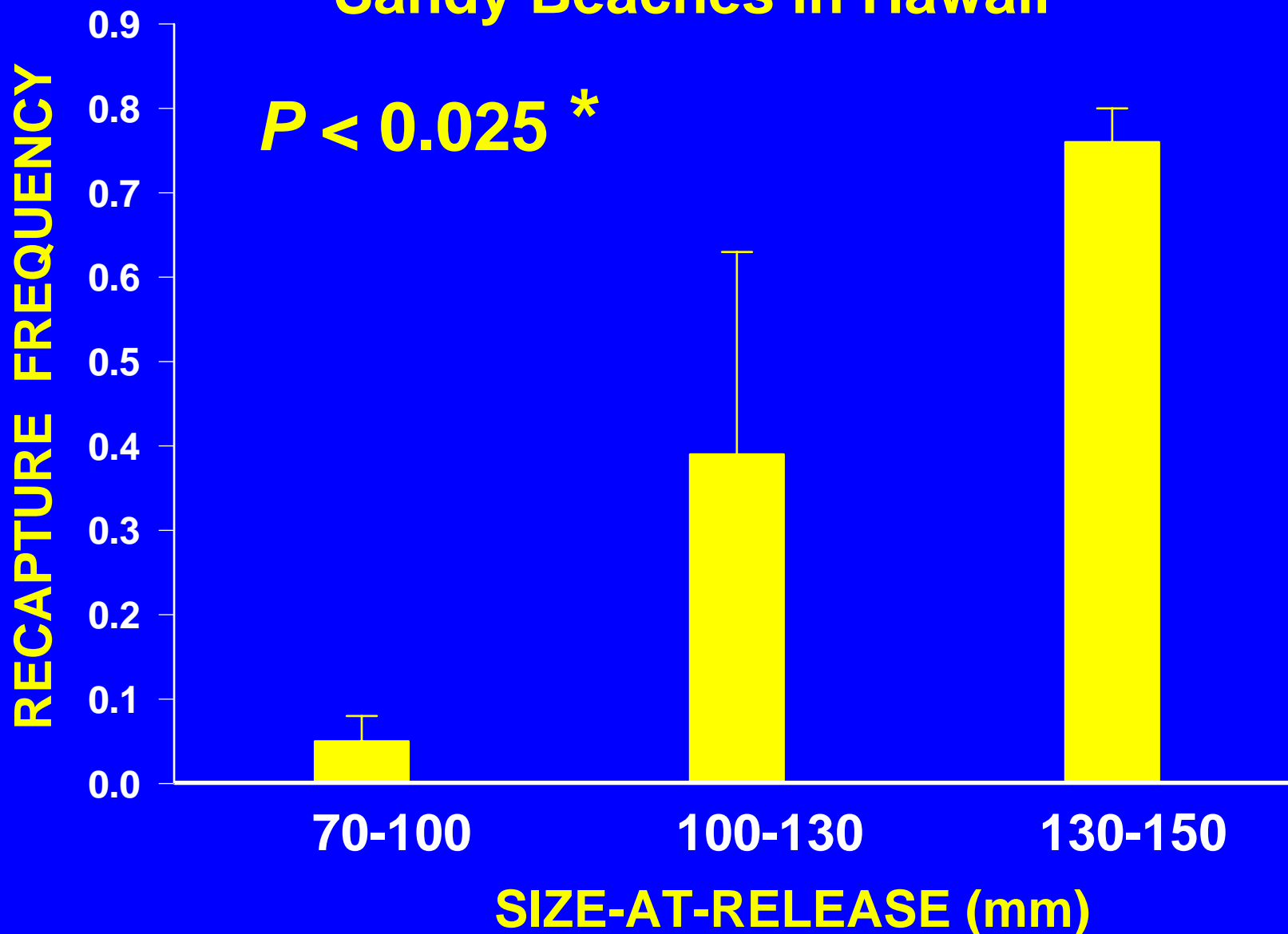
Optimal Release Protocol





Pacific Threadfin (Polynemidae) Recaptured Along Sandy Beaches in Hawaii

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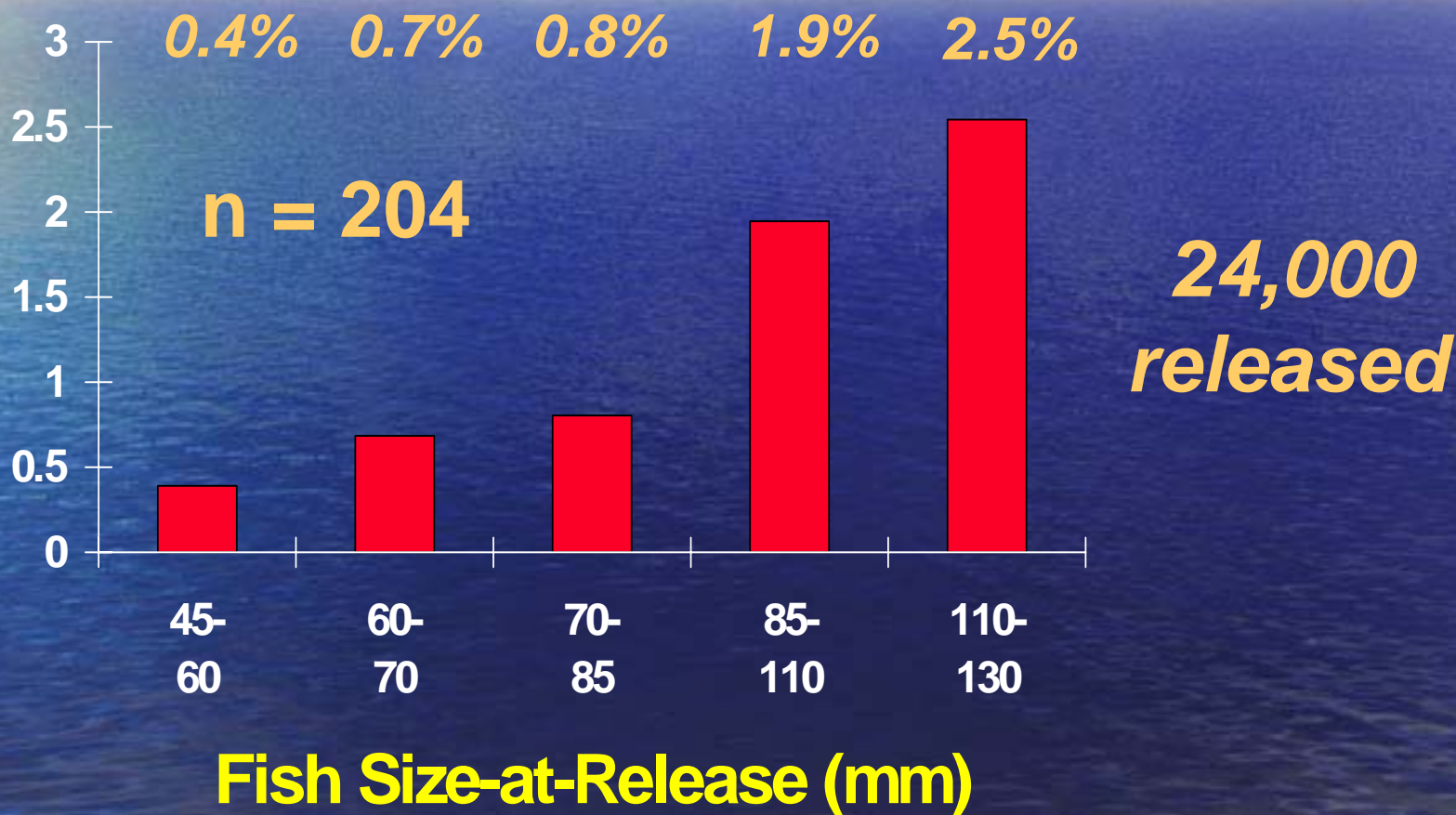


Leber, Brennan, Arce, *Bull. Mar. Sci* 62(2): 389-408, 1998



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Stocked Striped Mullet in Hilo Fishery (no. caught / no. released, * 100%)



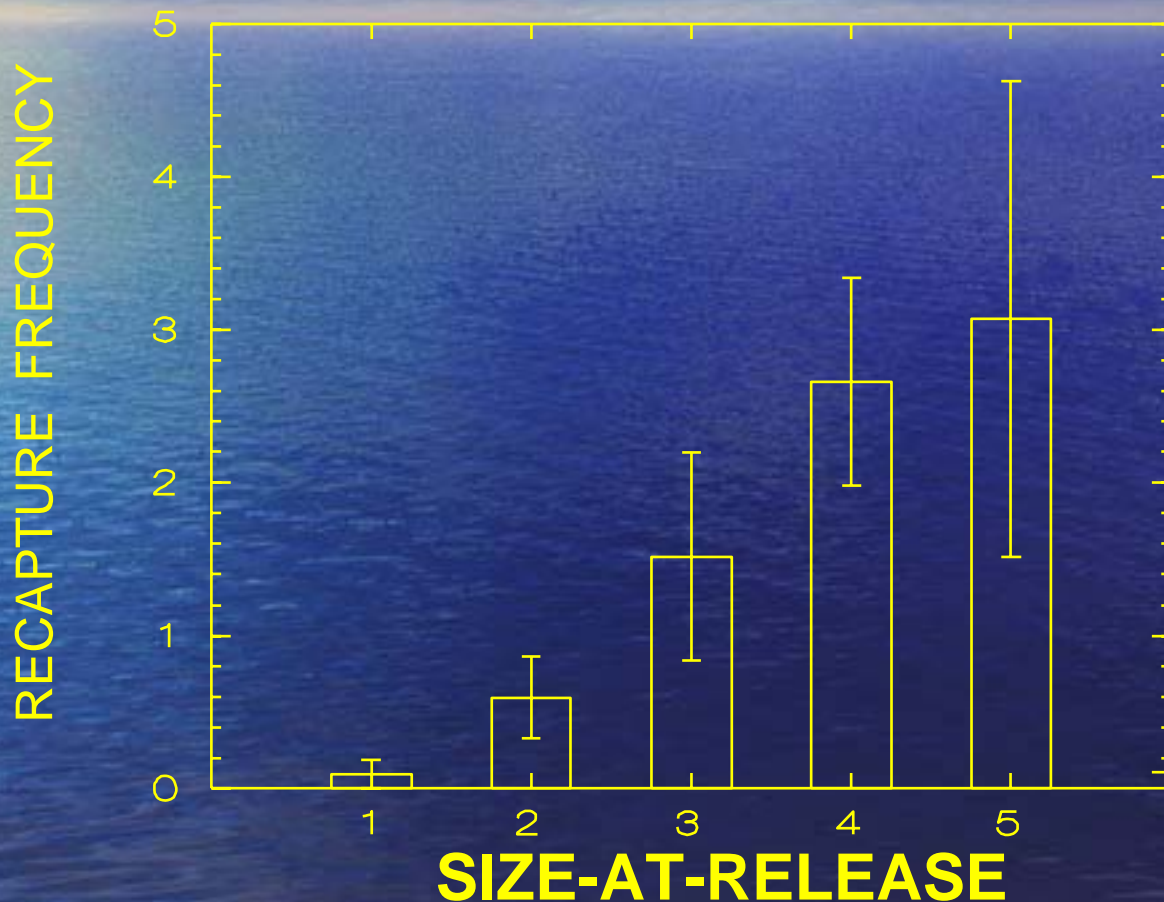
Leber, Sterritt, Cantrell, Nishimoto, *DLNR 95(1): 94-113, 1995*



Science Consortium for Ocean Resource Management

Size-at-Release Impact on Striped Mullet in Kaneohe Bay

RECAPTURES FOLLOWING SUMMER RELEASE

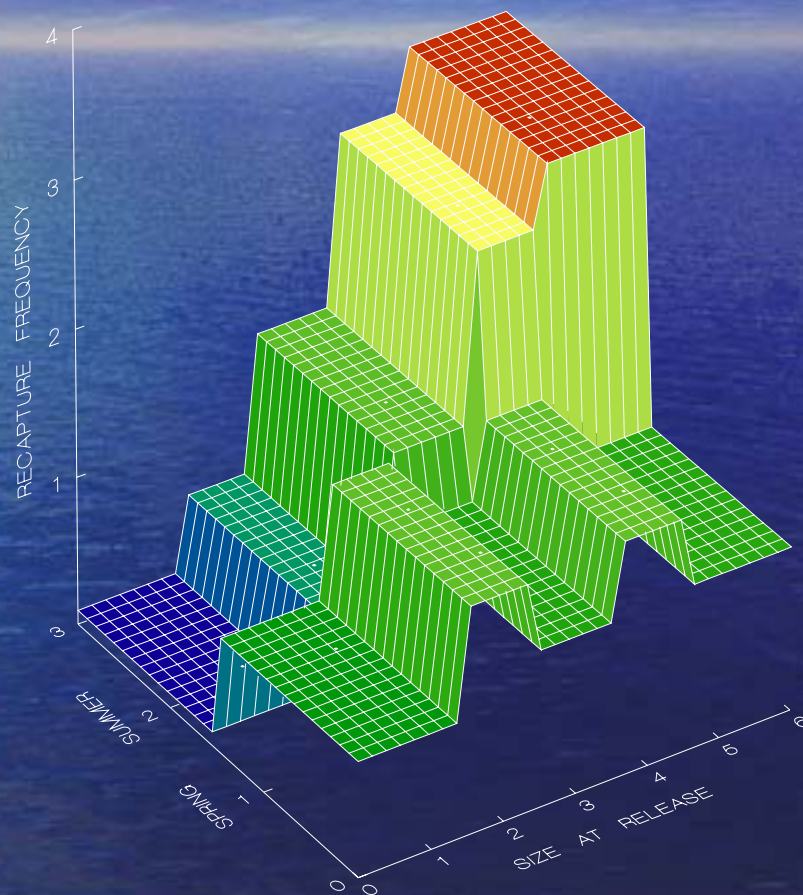


Leber, Arce, Sterritt, & Brennan, *Fishery Bulletin* 94(3): 452-472, 1996



Science Consortium for Ocean Replenishment

Release Season Interaction With Size-at-Release Effect



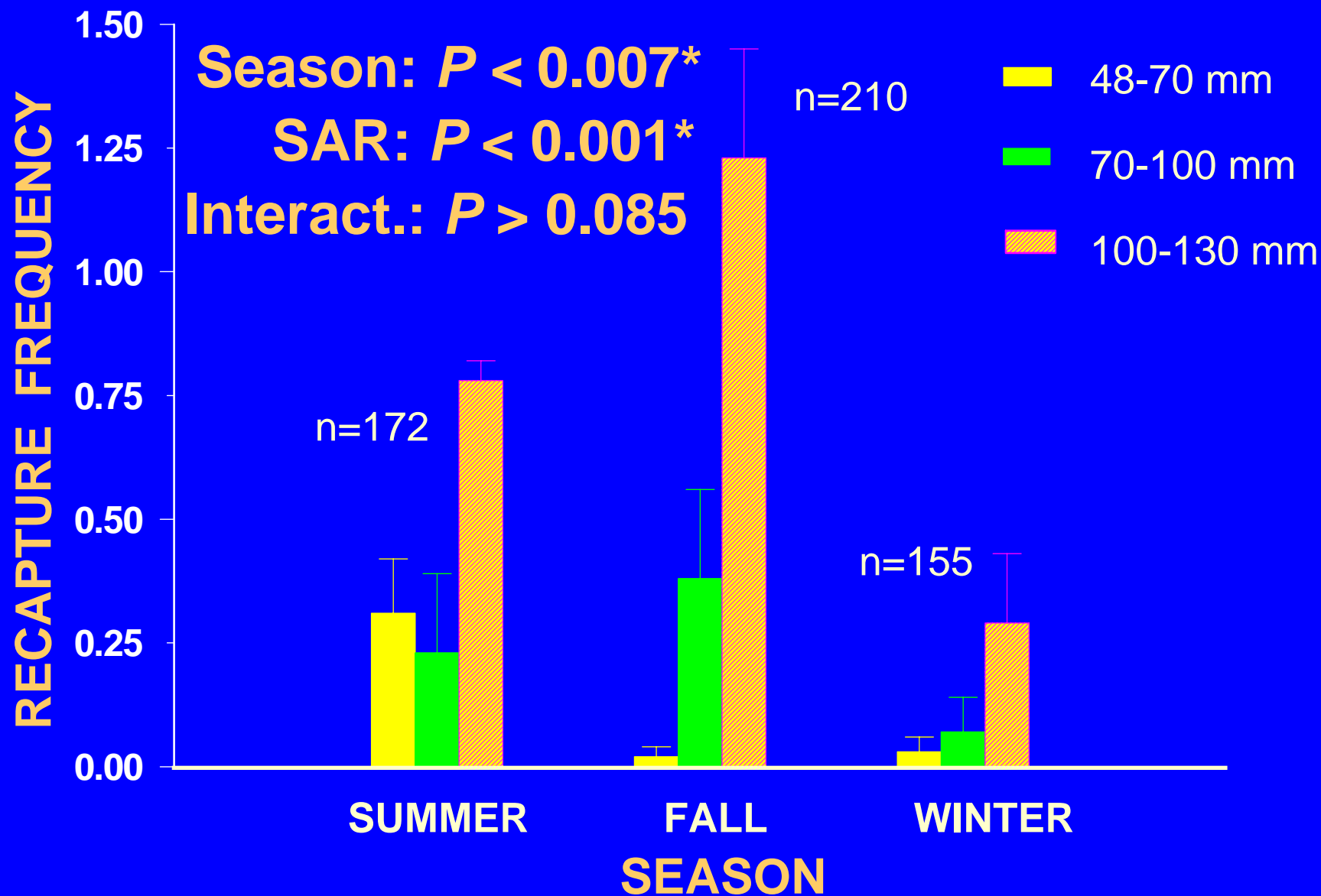
Leber, Blankenship, Arce, & Brennan, *Fishery Bulletin* 95(2): 267-279, 1997

Ken Leber Oct, 2005

ERF – 2005 Chesapeake Bay Symposium



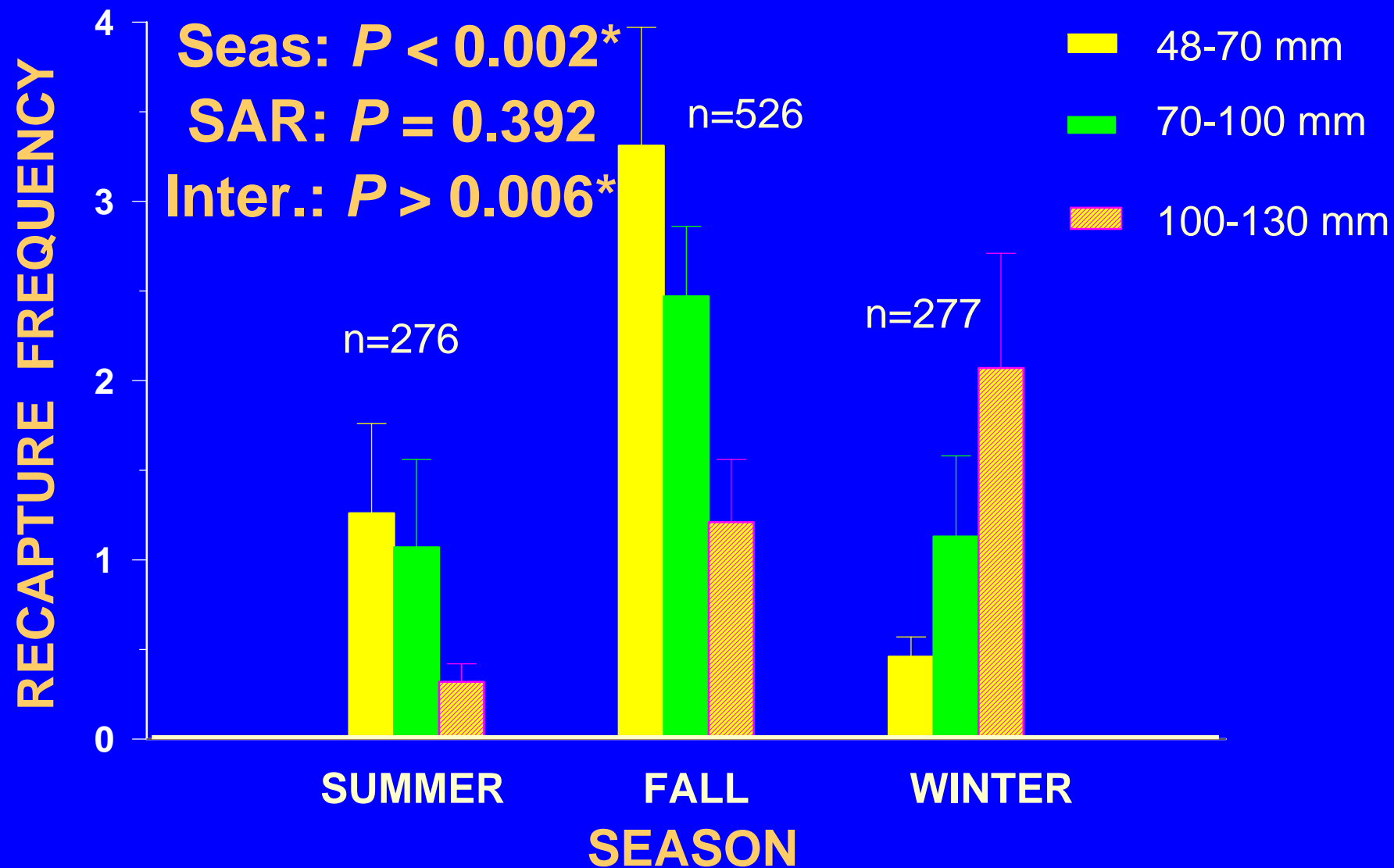
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Leber, Brennan, & Arce, *Bull. Mar. Sci* 62(2): 398-408, 1998



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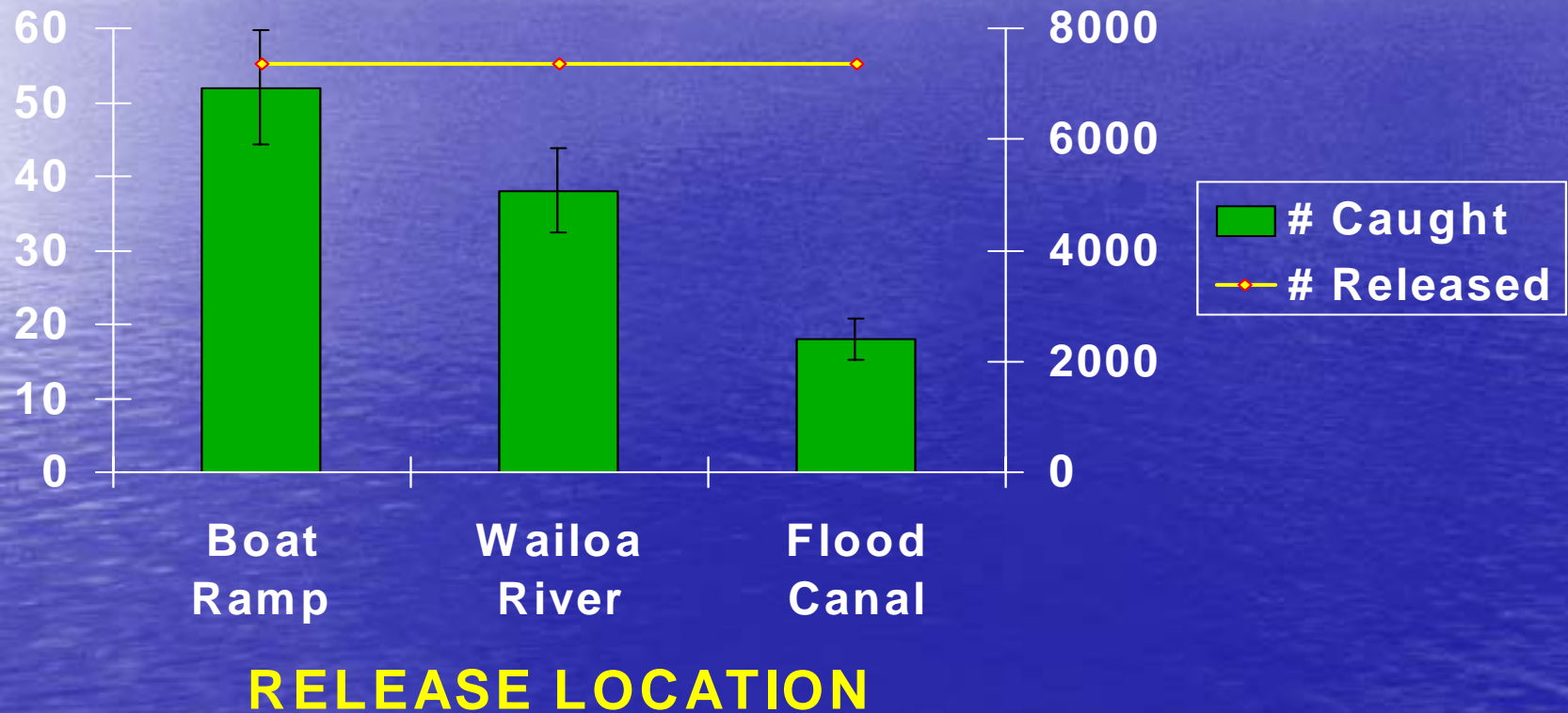


Leber, Brennan, & Arce, *Bull. Mar. Sci* 62(2): 398-408, 1998



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Release Microhabitat Effect

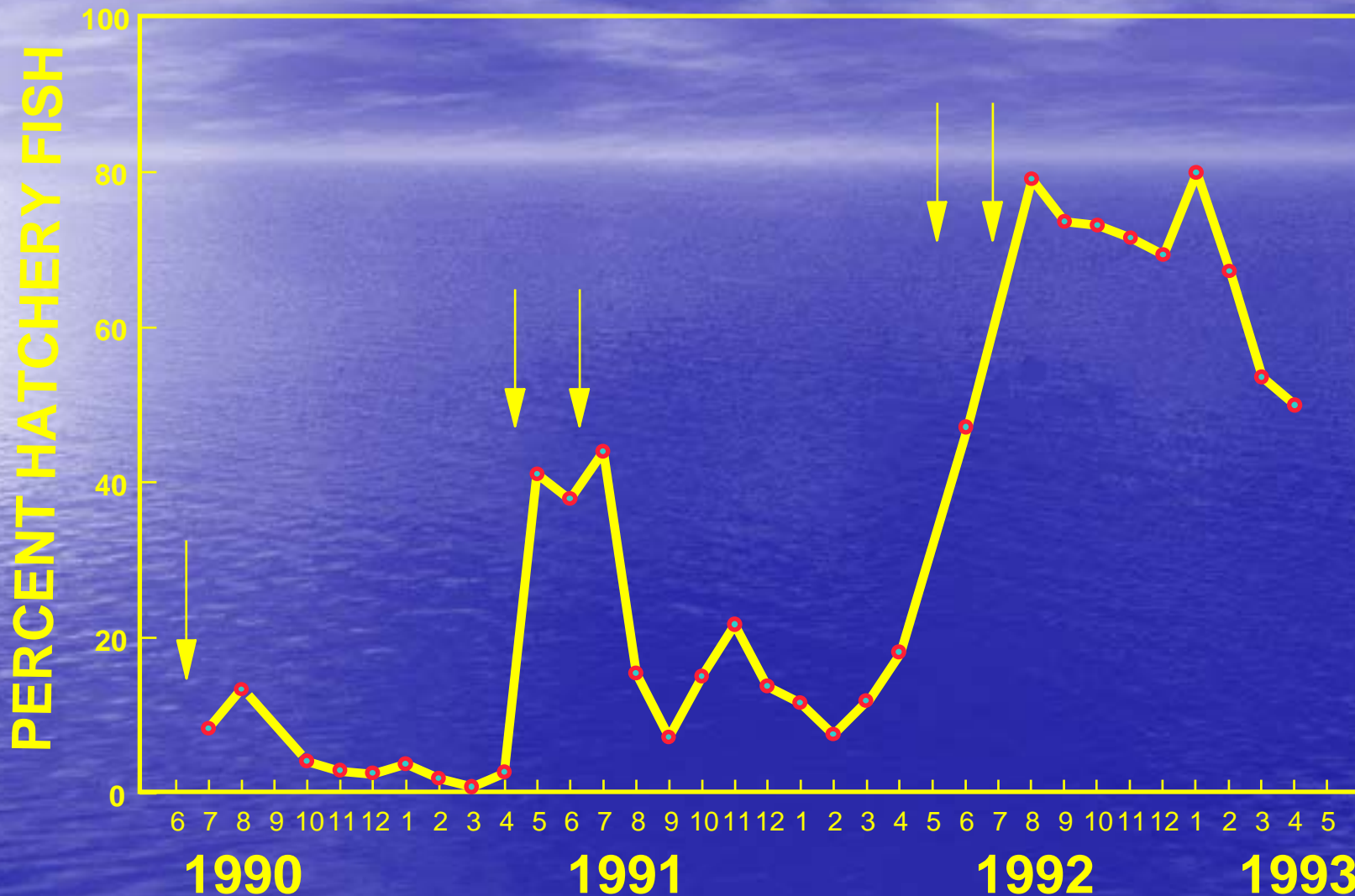


Leber, Sterritt, Cantrell, Nishimoto, *DLNR* 95(1): 94-113, 1995



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HATCHERY CONTRIBUTION



Leber, Arce, Sterritt, & Brennan, *Fishery Bulletin* 94(3): 452-472, 1996



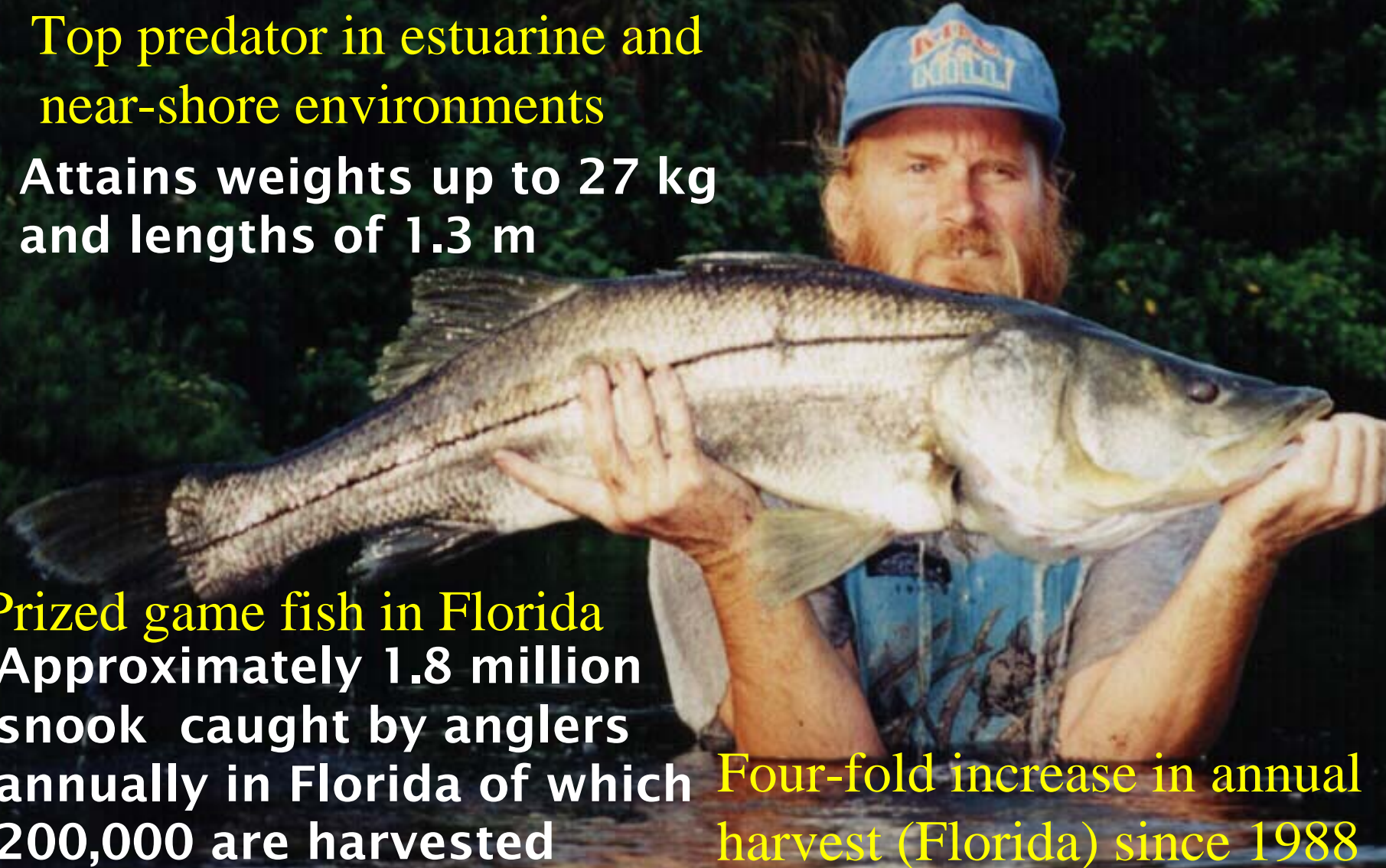
One of our *Guinea Pigs* in Florida: Common Snook (*Centropomus undecimalis*)

- Top predator in estuarine and near-shore environments

Attains weights up to 27 kg and lengths of 1.3 m

- Prized game fish in Florida
Approximately 1.8 million snook caught by anglers annually in Florida of which 200,000 are harvested

Four-fold increase in annual harvest (Florida) since 1988





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FWC/Mote Partnership on Snook Stocking

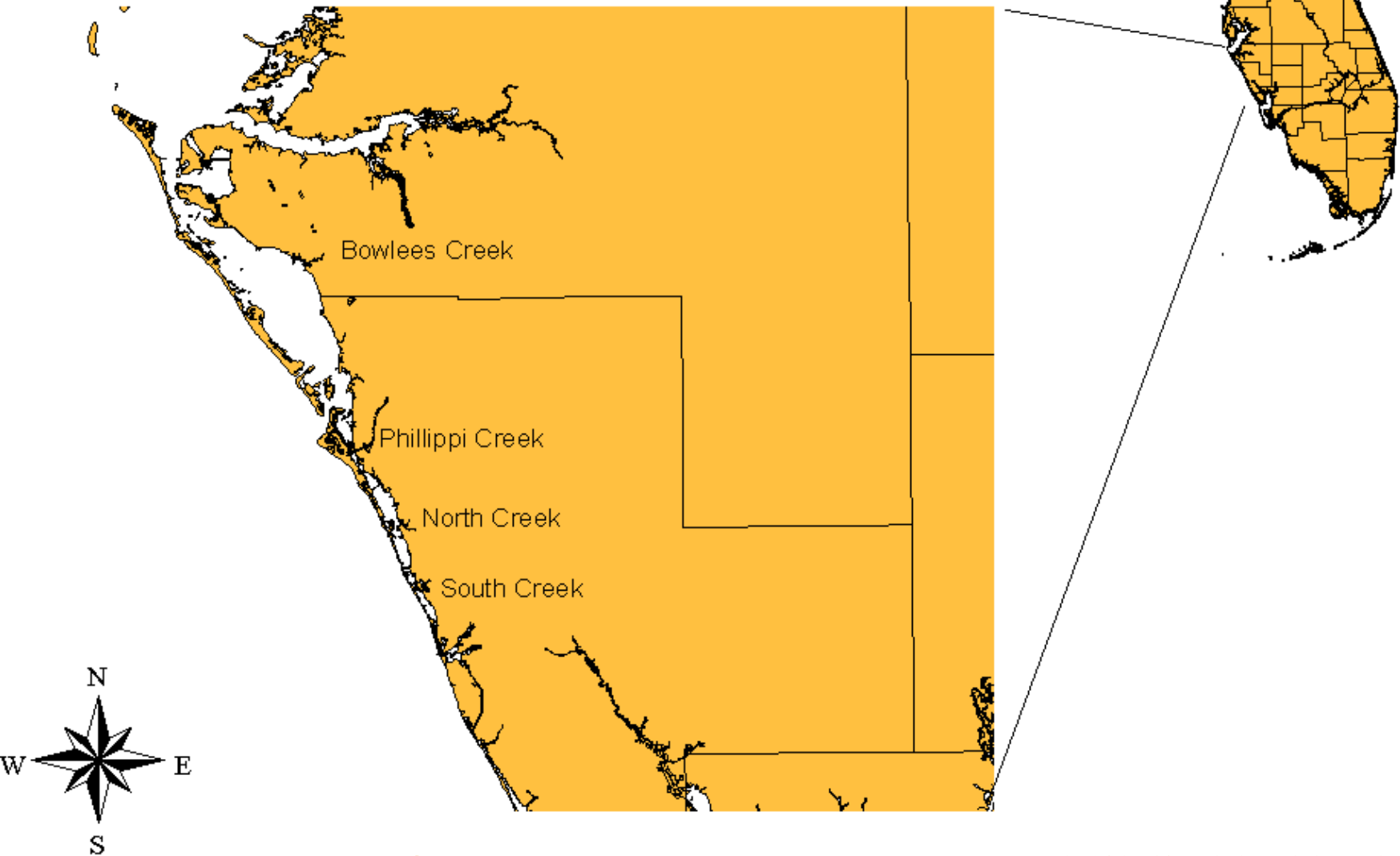


Pilot Releases
to Assess
Stocking
Effectiveness



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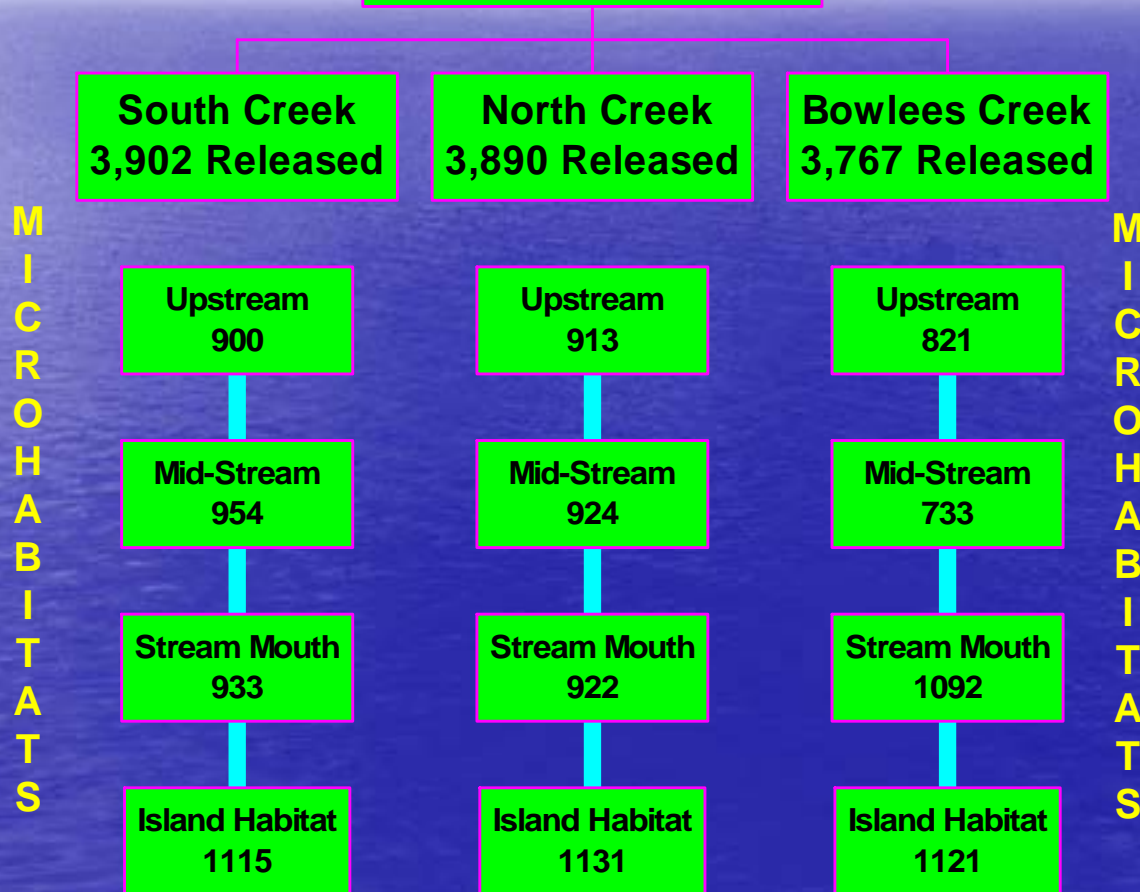
Study Site:



Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008

Release Micro-habitat studies (along a stream profile)

Release Habitats: 1998 and 1999



Brennan & Leber, in Review

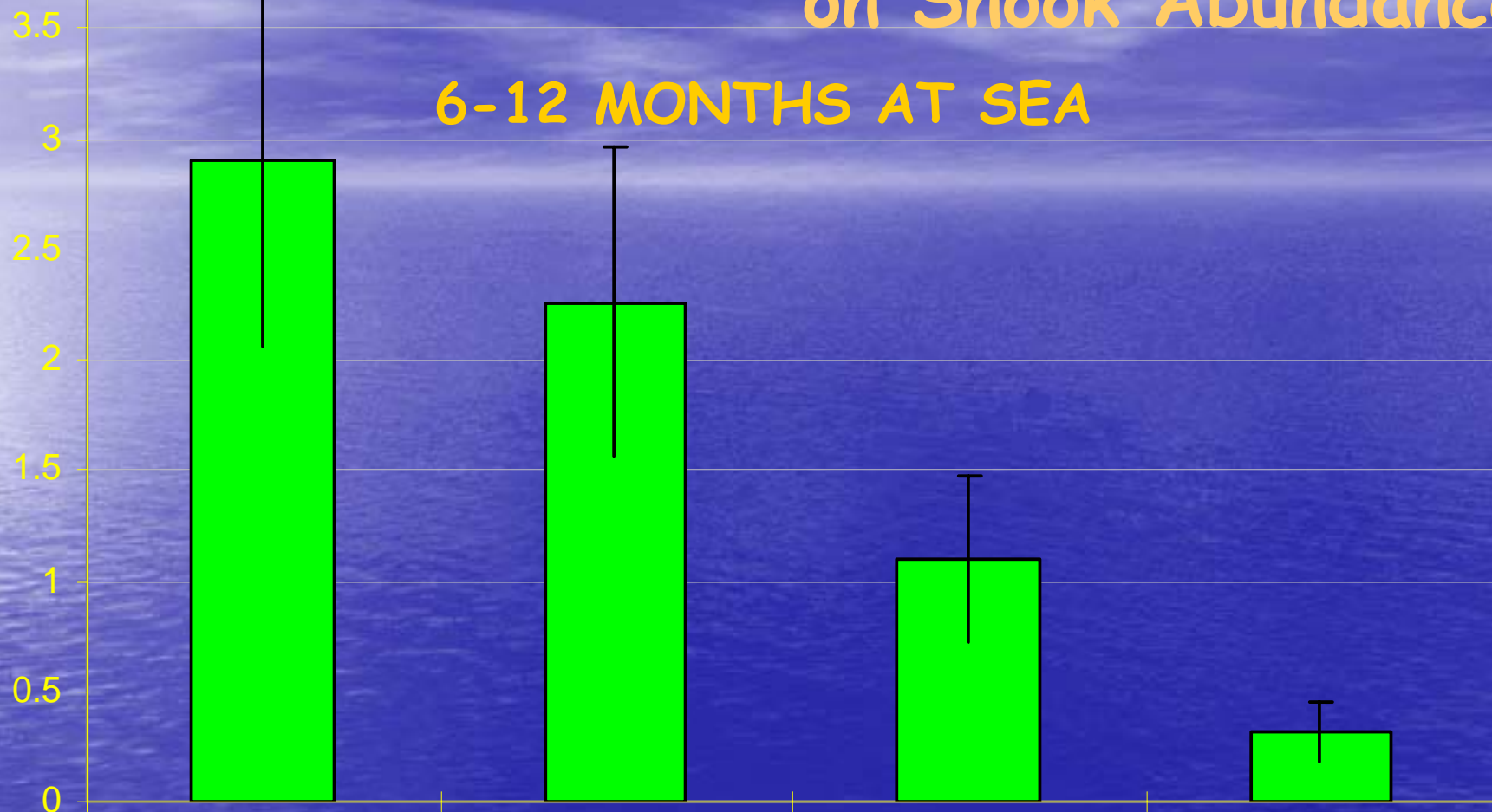


Release Microhabitat has Tremendous Effect on Snook Abundance

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6-12 MONTHS AT SEA

% RECAPTURED



Upstream

Midstream

Stream Mouth

Island Habitat

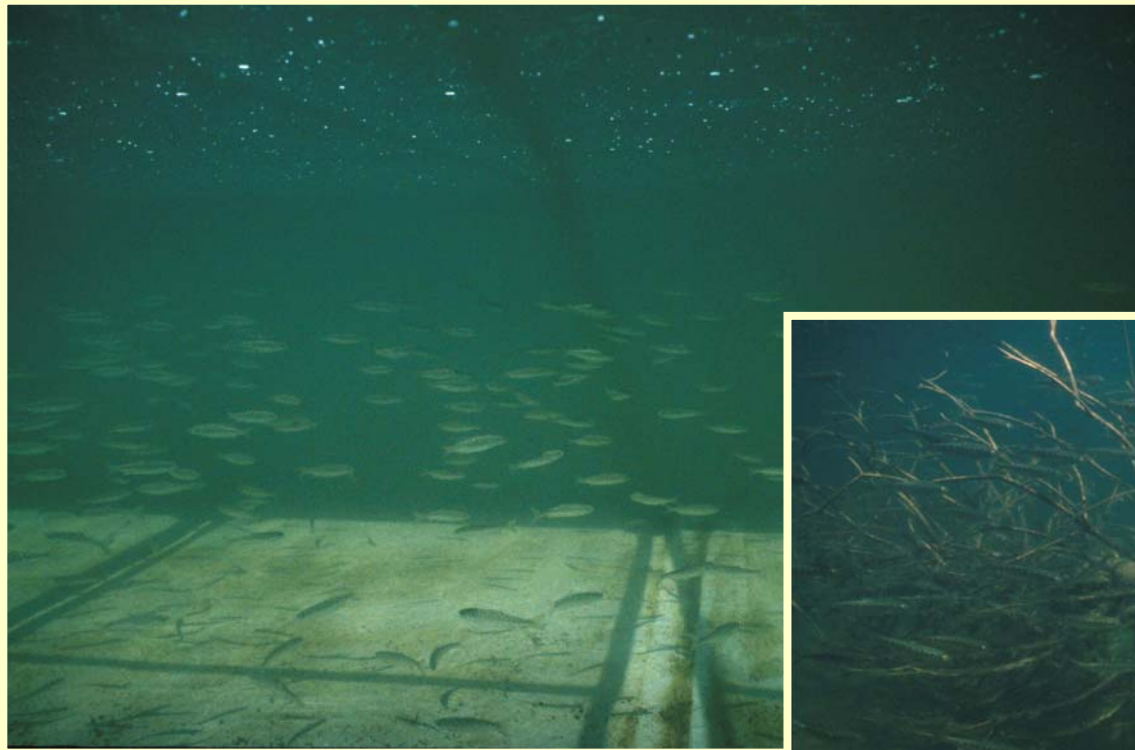
Release Site (coded wire tag info)

Brennan & Leber, in Review



Science Consortium for Ocean Replenishment

Structure, substrate and cover simulate natural rearing conditions



(D. Maynard)



Science Consortium for Ocean Replenishment

Environmental enrichment improves cryptic coloration of salmon smolts



(D. Maynard)



Acclimation and release sites

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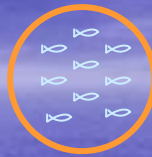


Release Design

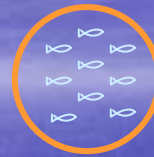
Day 1: Stocked Acclimation pens



NCO



NCL

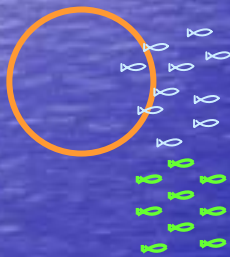


CCL

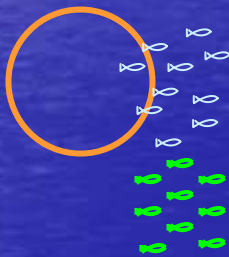


NCM

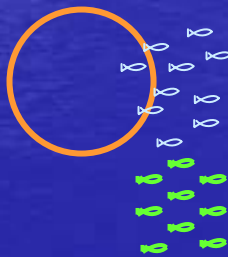
Day 3: Released snook from acclimation pens & also Stocked non-acclimated snook



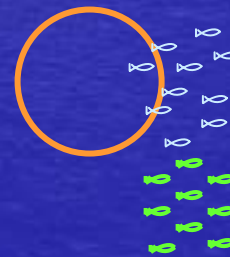
NCO



NCL



CCL



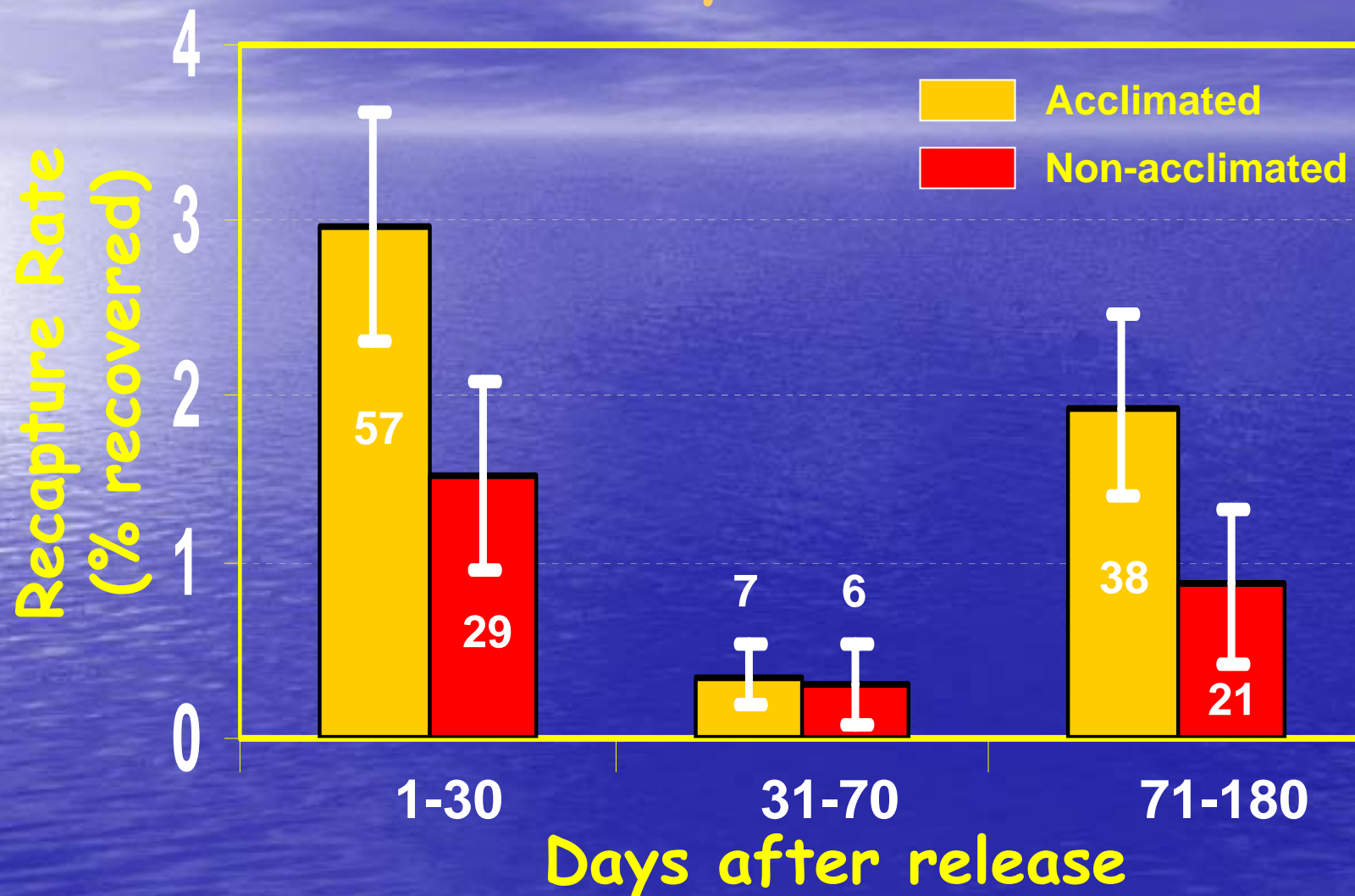
NCM

Replicated this experiment 3 times

Brennan, Darcy & Leber, *JEMBE* 335(2): 305-311, 2008



Acclimation effect on recapture rate Of hatchery-released snook



Brennan, Darcy & Leber, *JEMBE* 335(2): 305-311, 2008



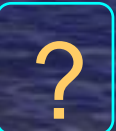


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Predictions:

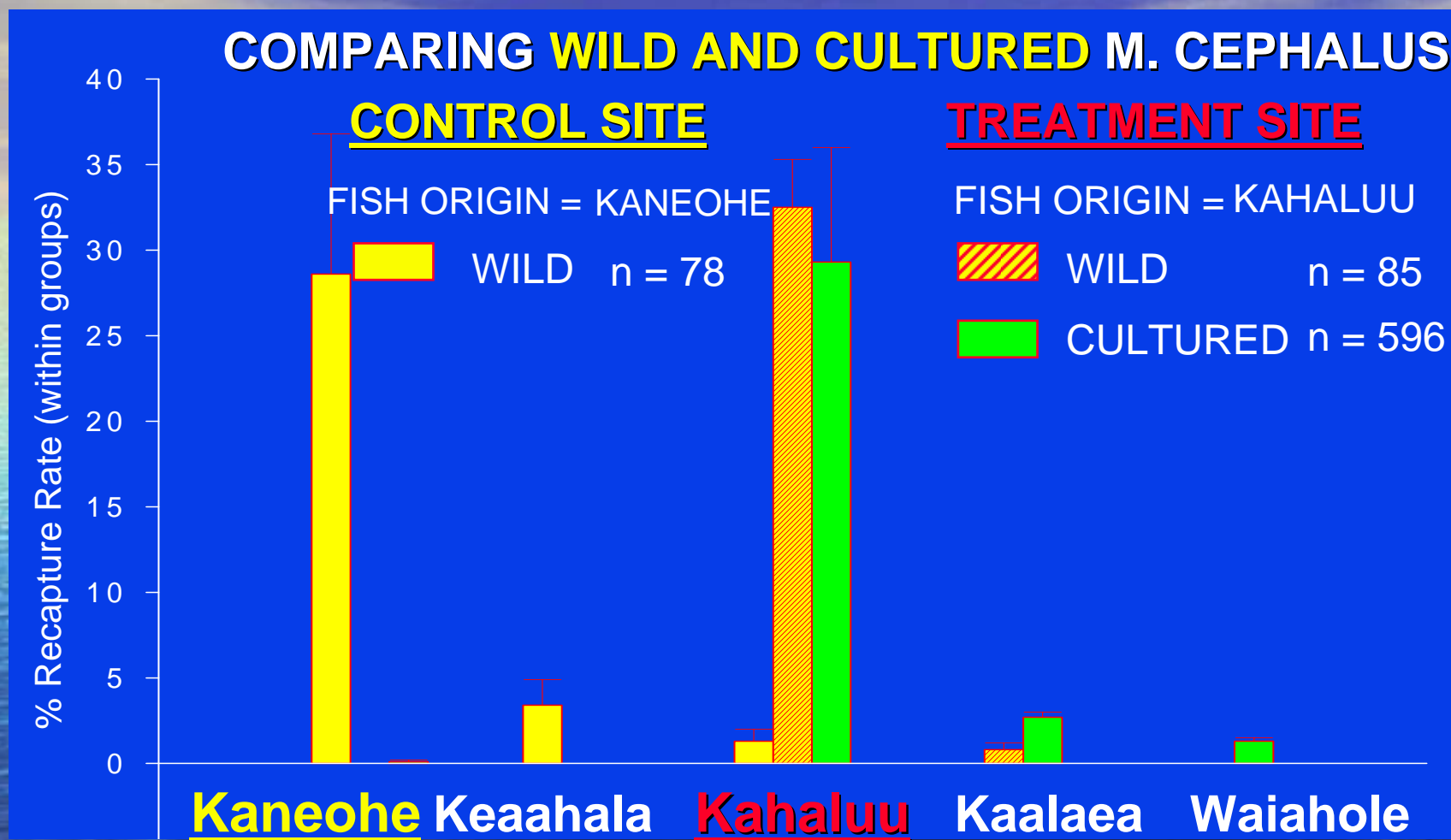
Hypothesis:

Marine Hatchery
Releases Increase
Fish Abundance

- ☀ Cultured Organisms Can Survive, Grow & Contribute to Fisheries 
- ☀ Stocked Organisms Do Not Displace Wild Individuals 
- ☀ Stocking to Increase Fishery Production is Economical 



Dispersal From Release Site

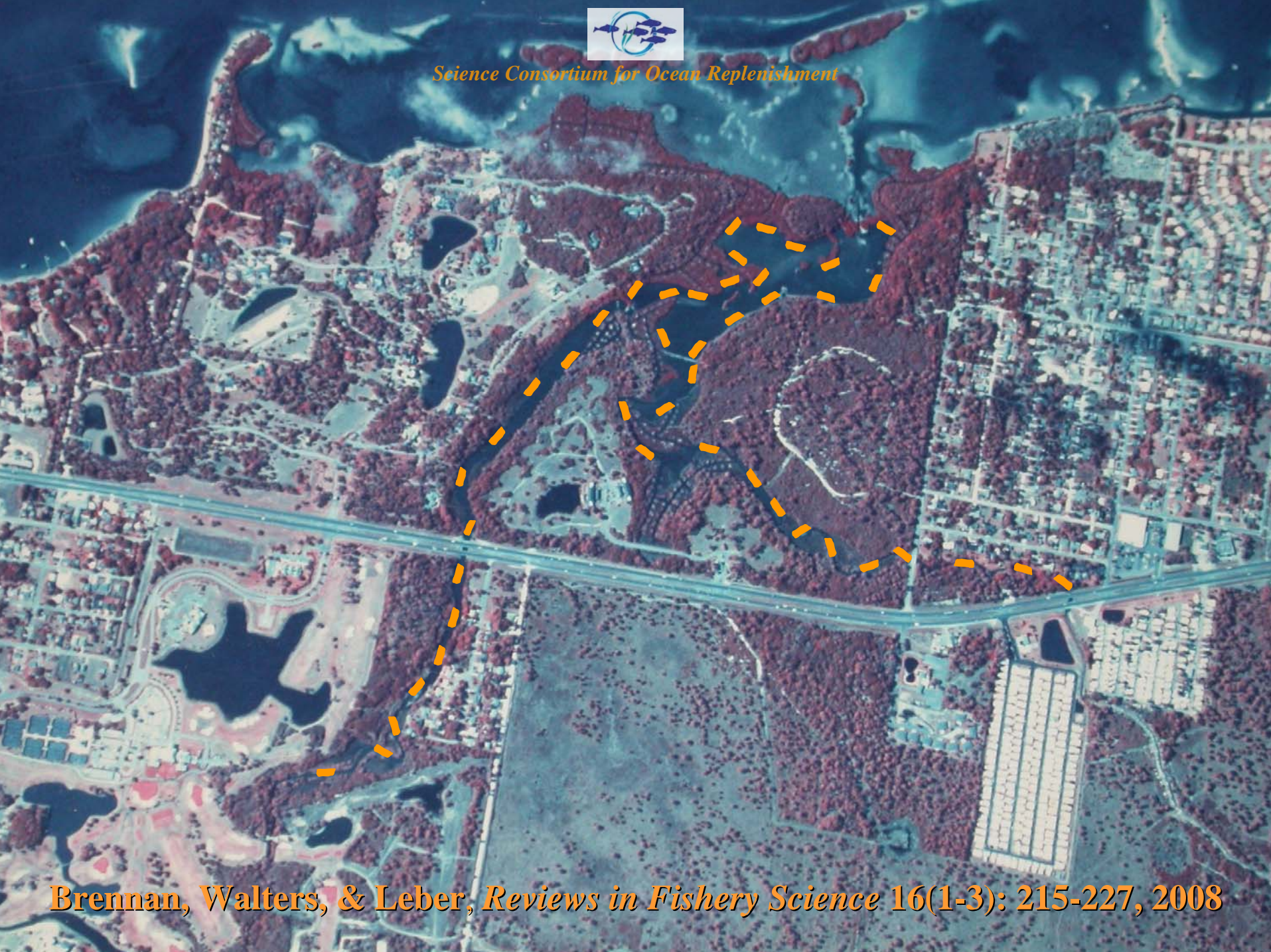


SHORELINE LOCATION IN KANEOHE BAY (North -->)

Leber, Brennan & Arce, American Fishery Society Symp 15: 376-387, 1995



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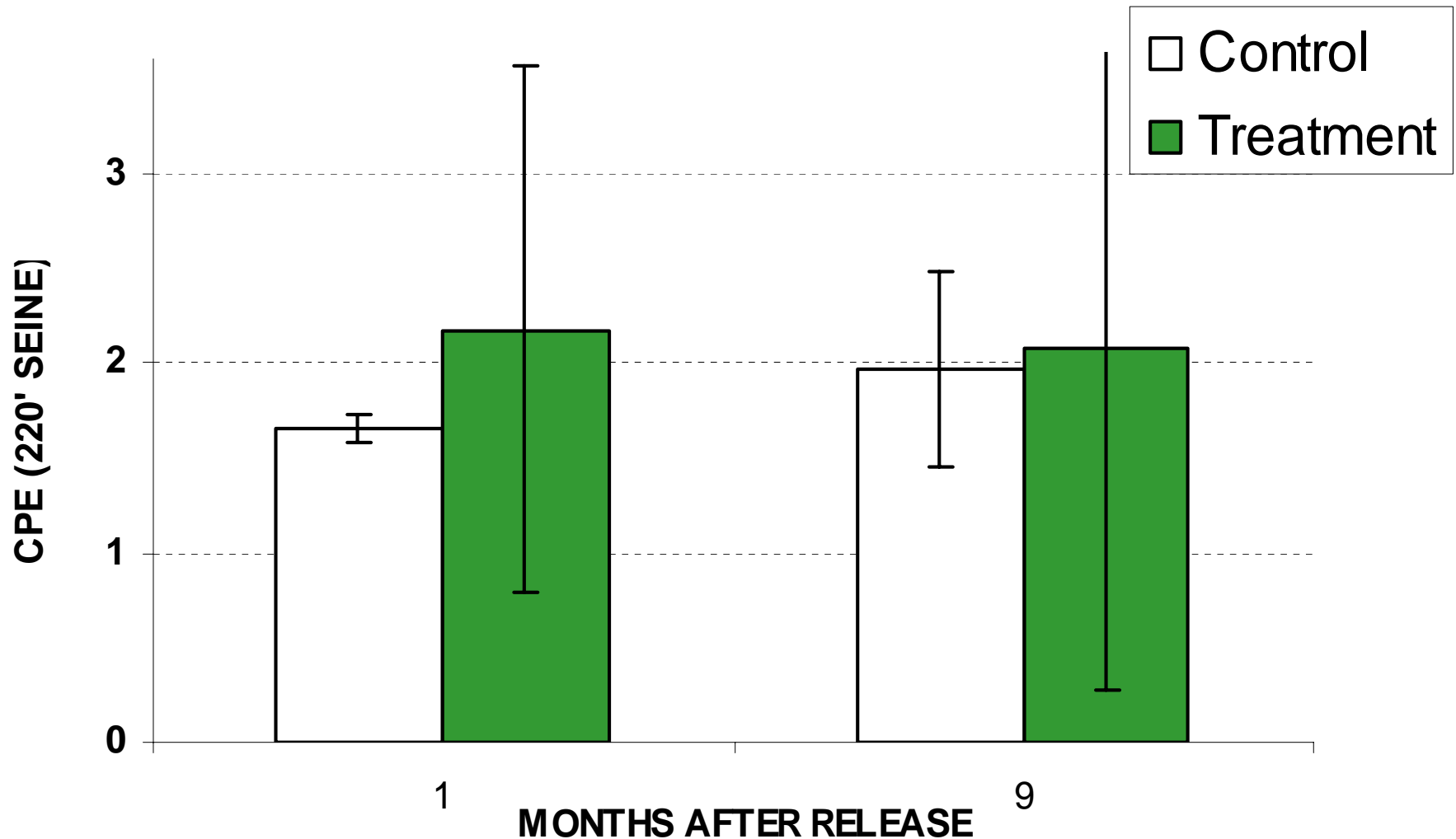


Brennan, Walters, & Leber, Reviews in Fishery Science 16(1-3): 215-227, 2008



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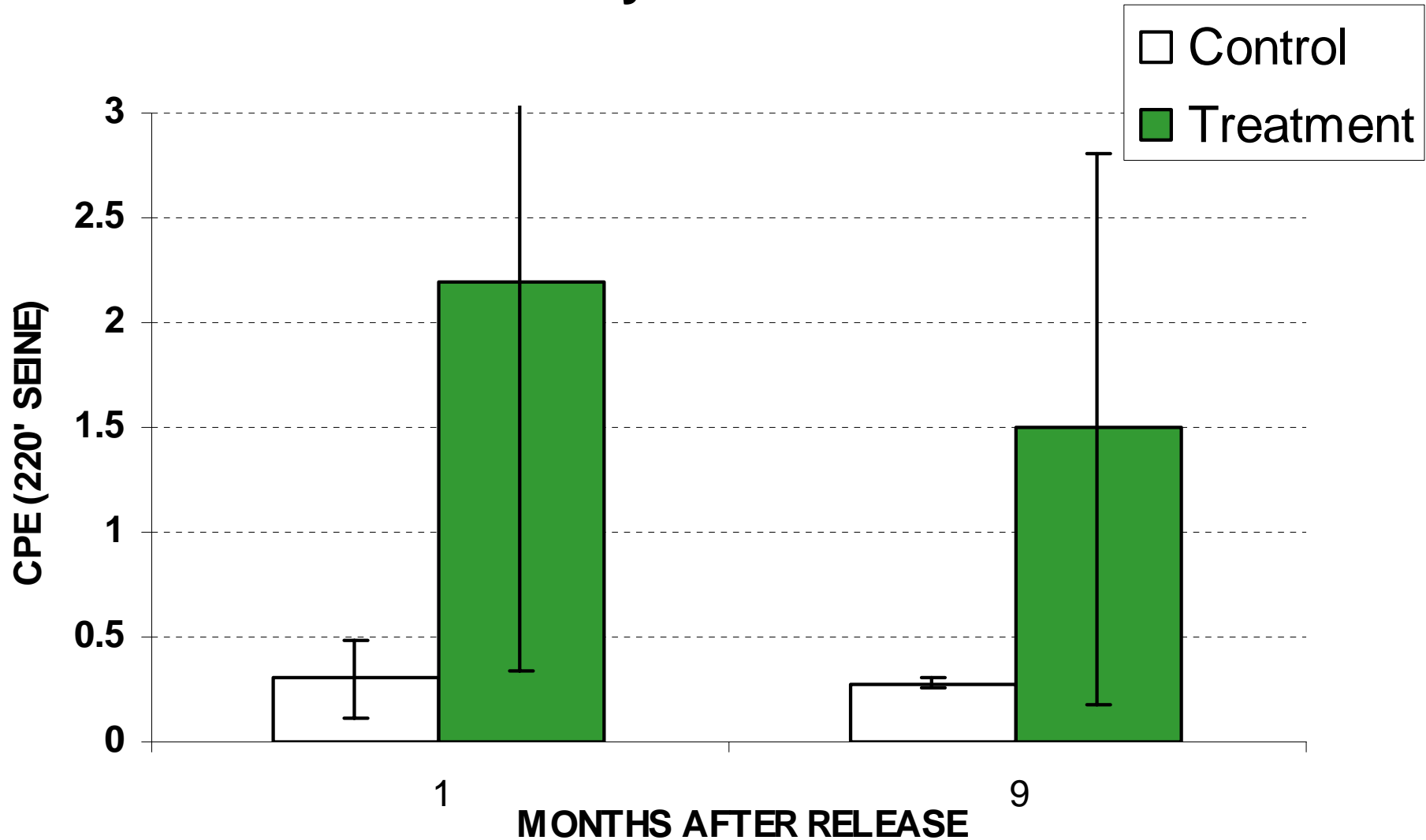
Mean wild snook abundance



Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008



Mean hatchery snook abundance



Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008

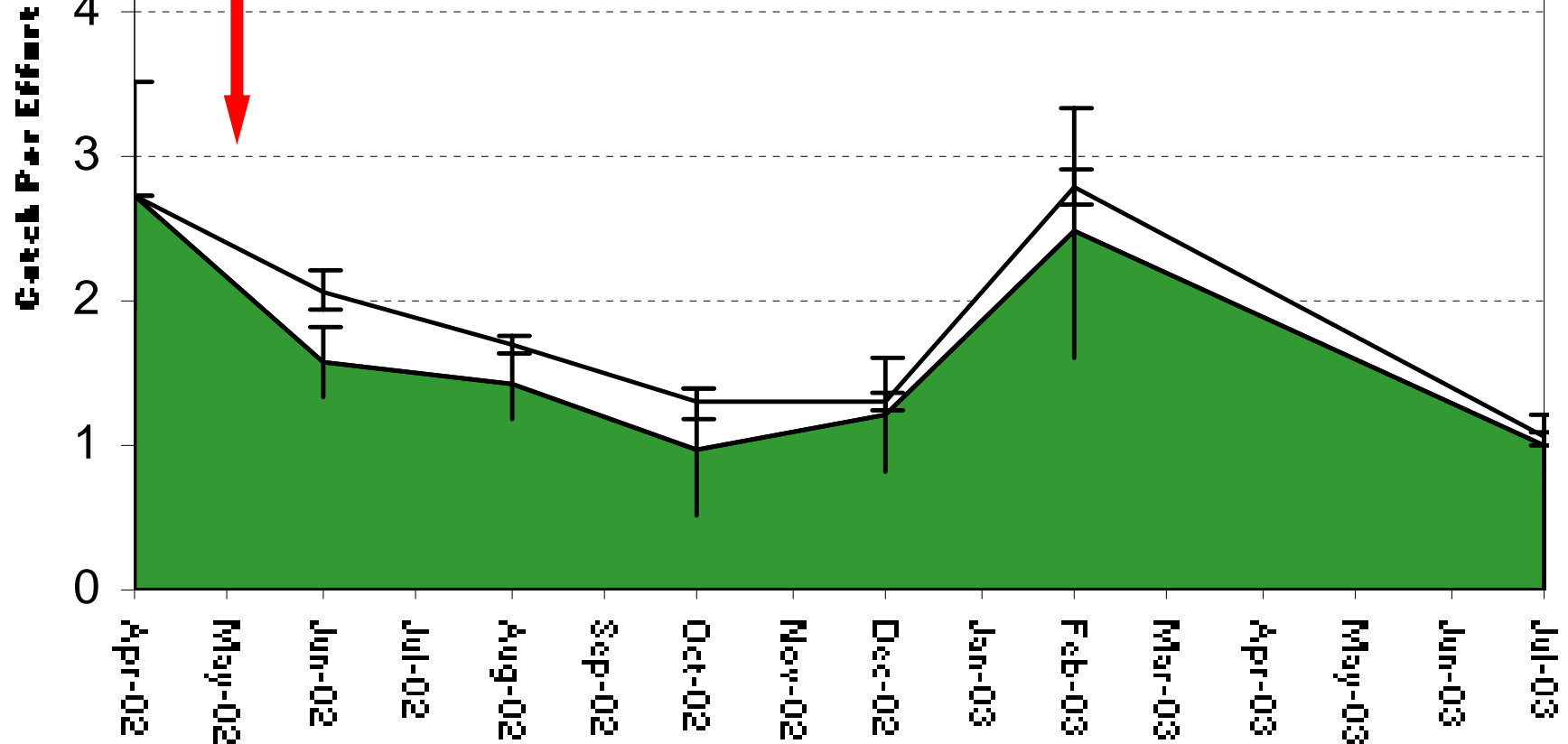


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North Creek

□ Hatchery Age-0

■ Wild Age-0

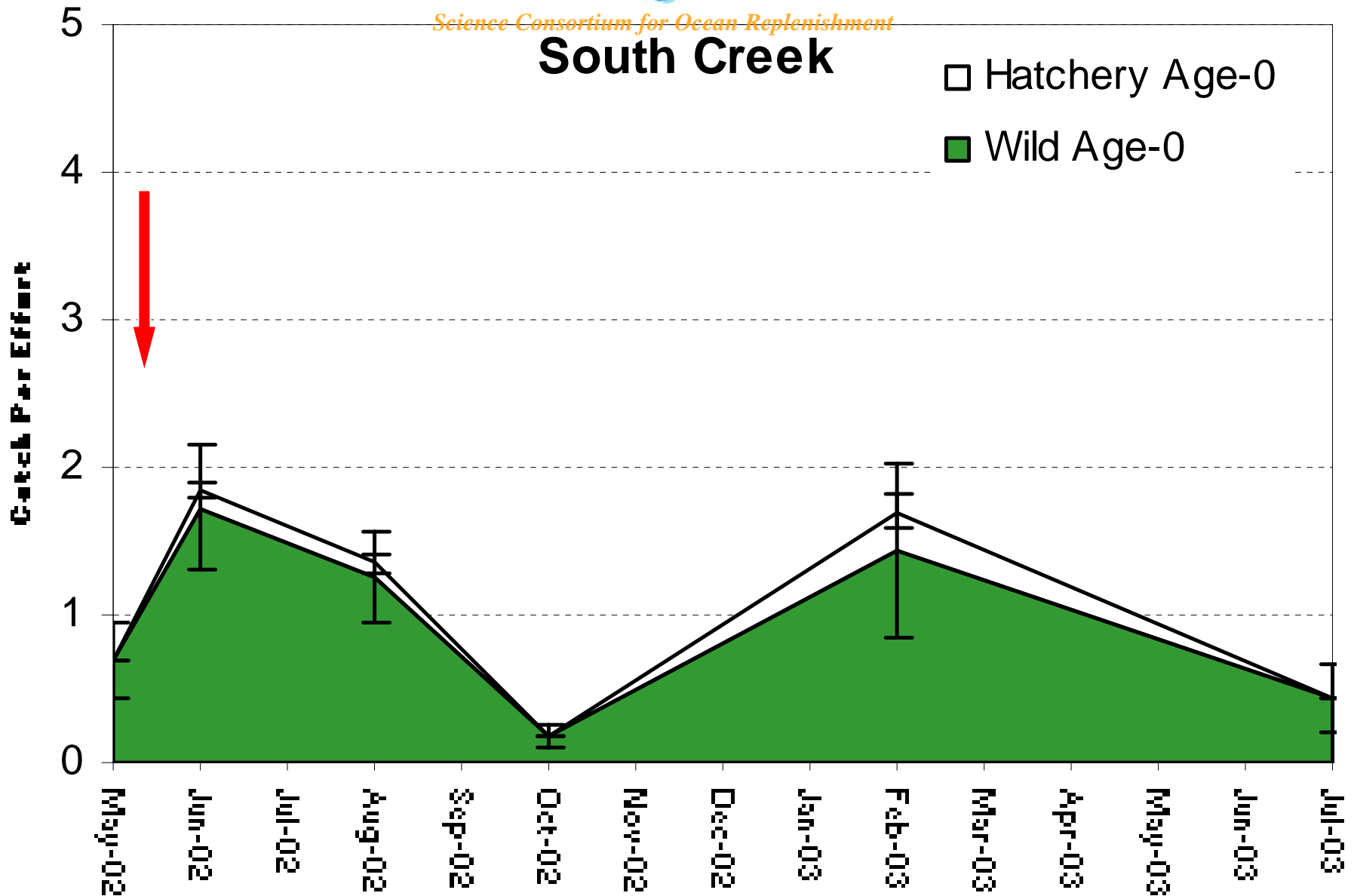


Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008



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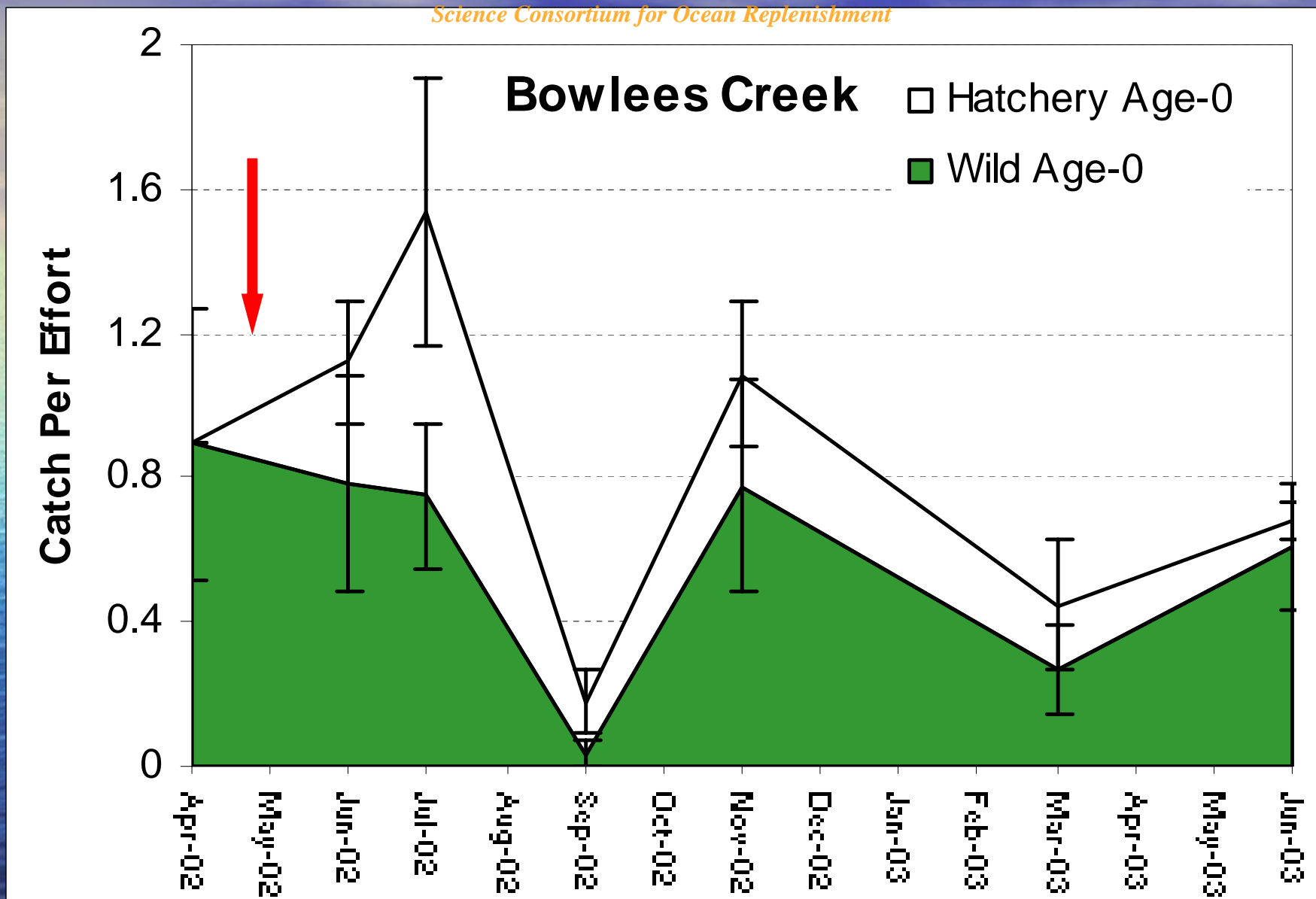
South Creek



Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008



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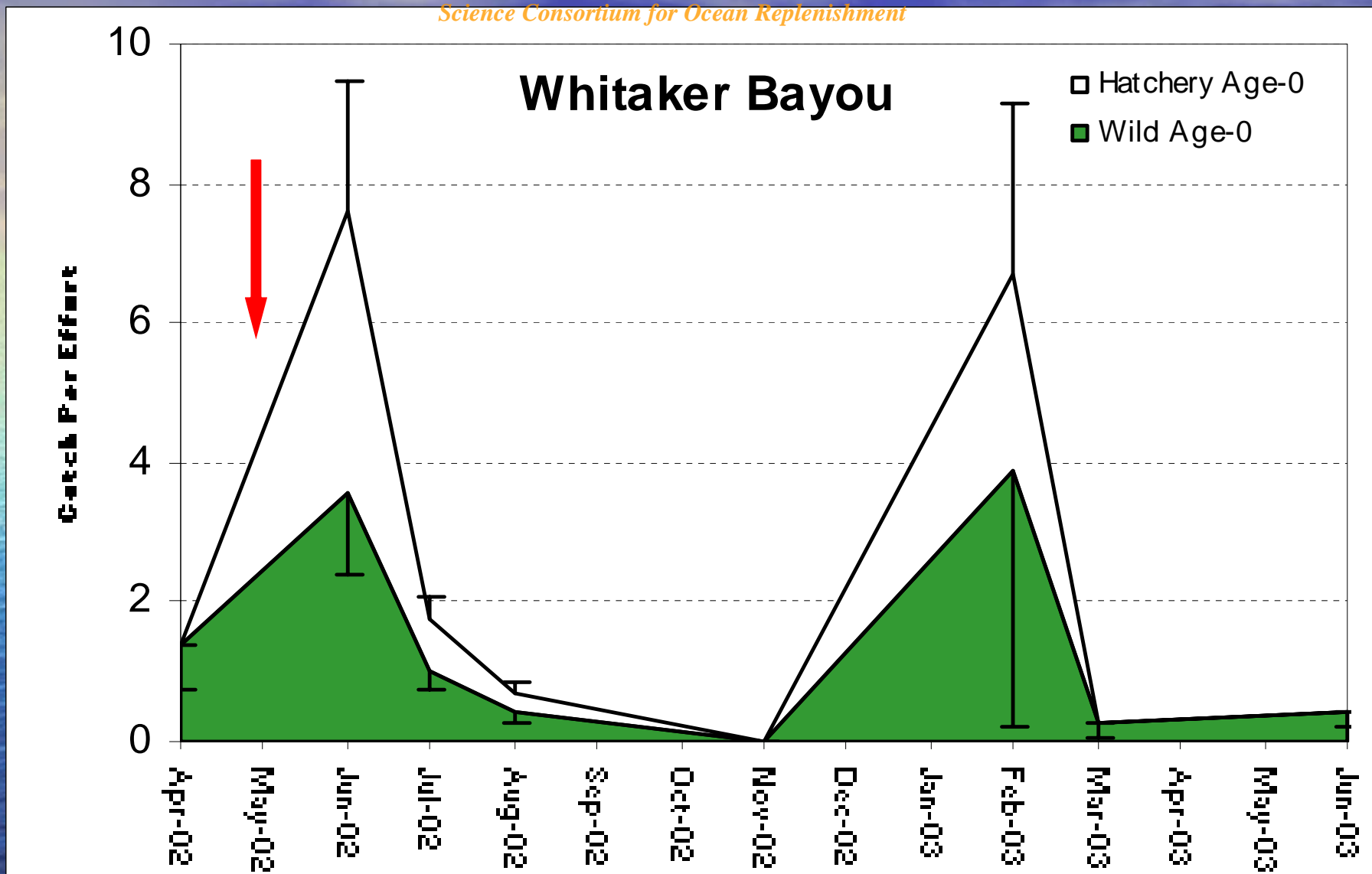
Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008

Ken Leber, Oct 2005

ERF – 2005 Chesapeake Bay Symposium



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Brennan, Walters, & Leber, *Reviews in Fishery Science* 16(1-3): 215-227, 2008



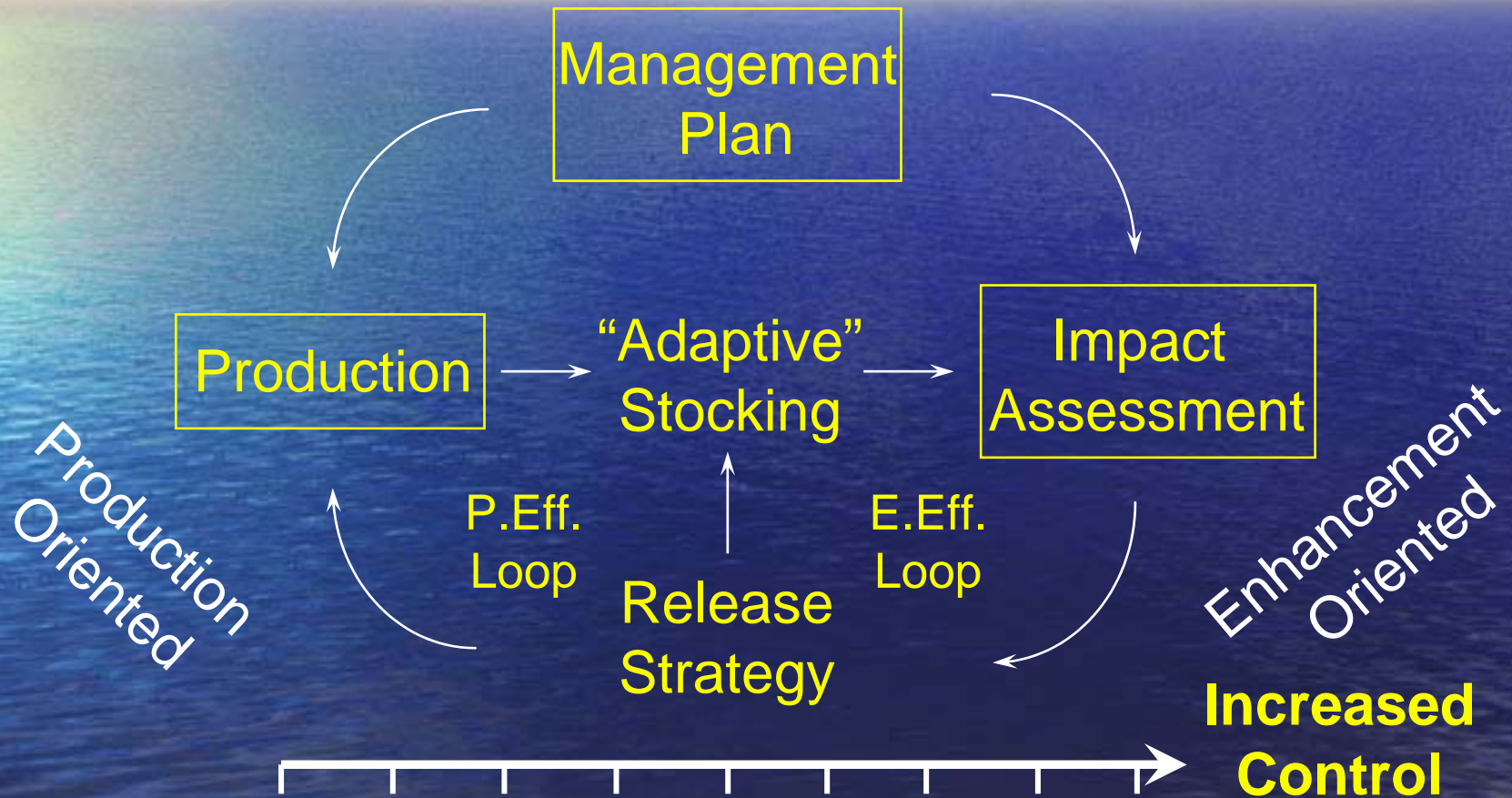
Summary of Release Experiments

- ☀ No strong displacement effect evident on wild yearlings
- ☀ Perhaps a displacement effect on hatchery yearlings
- ☀ Major gains in effectiveness by understanding release strategy impacts on survival (and growth)
- ☀ Clear opportunities to gain even better survival by concentrating more on conditioning prior to release
- ☀ There is no quick fix from stocking; needs rigorous attention to a responsible approach & an adaptive management approach



Adaptive Management is Crucial

Recognize “Production - Enhancement”
management dichotomy



Leber, In: *Responsible Marine Aquaculture*, CABI Publ. New York, pages 79-90, 2002

Ken Leber, Oct 2005

ERF – 2005 Chesapeake Bay Symposium



Science Consortium for Ocean Replenishment

HATCHERY SNOOK RELEASES

(In Sarasota Bay and nearby waters)

| | | |
|-----------------|-------------|---------------|
| APRIL | 1997 | 6,334 |
| DECEMBER | 1997 | 5,364 |
| APRIL | 1998 | 11,884 |
| APRIL | 1999 | 9,510 |
| APRIL | 2000 | 4,183 |
| APRIL | 2001 | 2,634 |
| MAY | 2002 | 2,477 |
| MAY | 2003 | 7,735 |

| | |
|-----------------------|---------------|
| TOTAL RELEASED | 50,121 |
|-----------------------|---------------|



Science Consortium for Ocean Replenishment

ANNUAL SNOOK ROUNDUP

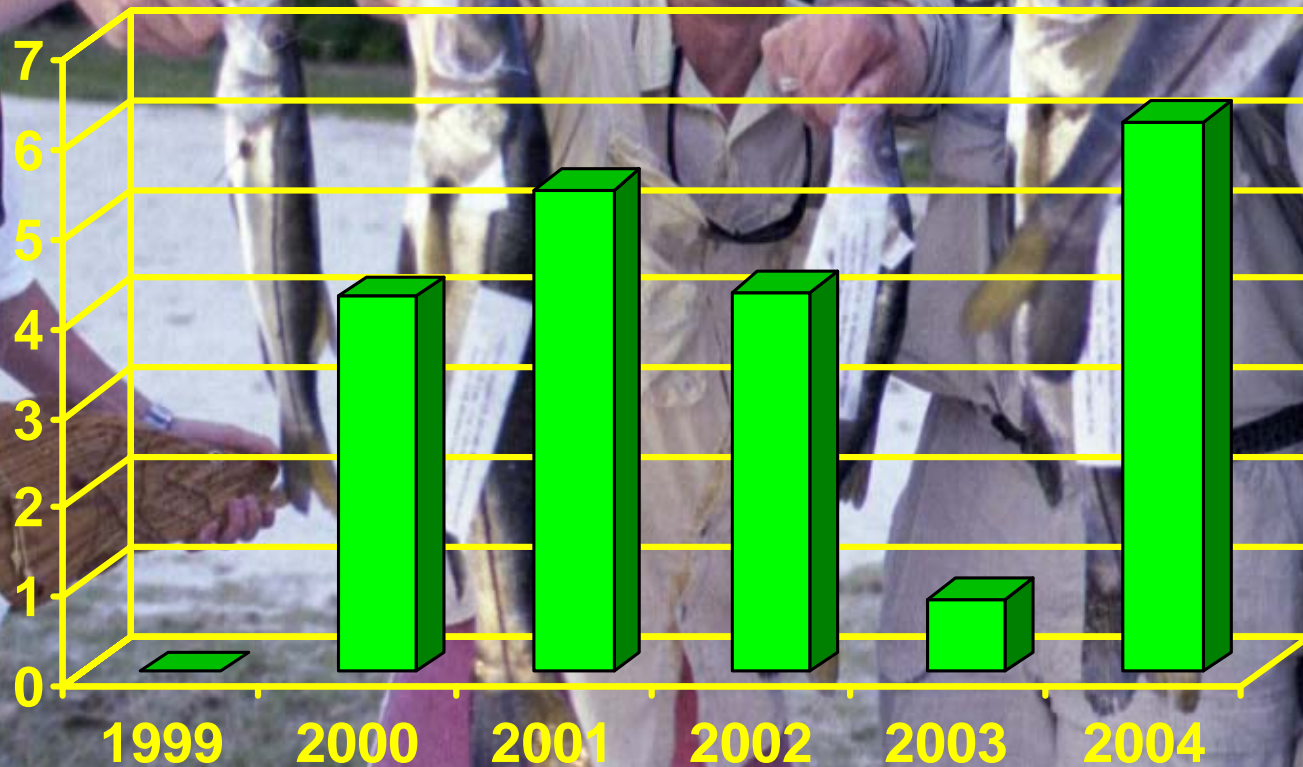




Stocking clearly contributes to marine fisheries

Science Consortium for Ocean Replenishment

PERCENT HATCHRY FISH



Leber and Brennan, *In Review*



Science Consortium for Ocean Replenishment

**Hatchery Snook Released at 8 " in
Apr 1998 in Bowlees Creek --
caught Apr. 2002 at 28" in Bowlees
Creek**





Science Consortium for Ocean Replenishment



**34" Hatchery Snook -- 6" when
released Apr 1999 in Bowlees Creek
Caught July 2004 in Bowlees Creek**



Science Consortium for Ocean Replenishment

Key Points

- Status of stock enhancement – Intermediate stage of development.
- Research partnerships and a *multi-disciplinary, adaptive-management approach* are needed to move the field forward.

Acknowledgements and

Science Consortium for Ocean Replenishment

Appreciation (Florida S/E Research)

- ★ Nathan Brennan
- ★ Lee Blankenship
- ★ Bill Halstead
- ★ Roger DeBruler
- ★ Cindy Armstrong
- ★ John Ransier
- ★ Greg Vermeer
- ★ Roy Yanong
- ★ Michael Tringali
- ★ Chris Young
- ★ NOAA-Fisheries
- ★ Kevan Main
- ★ Michael Nystrom
- ★ Dave Jenkins
- ★ Heather Hamlin
- ★ Bill Falls
- ★ Harry Grier
- ★ Carole Neidig
- ★ Gina Russo
- ★ Mr. William R. Mote
- ★ FWRI & FWC